General epidemiology of communicable diseases

Definitions

- **Infection:** It is the entry ,development and multiplication of an infectious agent in the body of man or animal.
- Infectious disease: A clinically manifest disease of man or animal resulting from infection.
- Subclinical infection (In-apparent infection): The infection does not become manifest at any stage.

- **Latent infection:** The infectious agent lies dormant within the host body, without any clinical manifestations. After a period of time, under certain circumstances, it reactivates and produces disease e.g. herpes Zoster
- **Opportunistic Infections:** disease caused by infectious agents which are normally not pathogenic due to a cline in the general or specific immune status of the host e.g. Toxoplasma gondi.

Patterns of occurrence of disease in communities

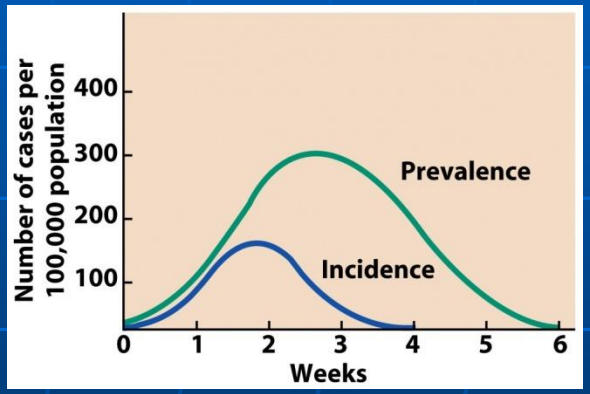
- Sporadic
- Endemic
- Epedemic
- Pandemic
- Outbreak: Amore or less localized epidemic affecting large number of a group in the community e.g. outbreak of food poisoning
- Exotic disease
- Enzootic: Endemic disease occuring among animals
- Epizootic: Epidemic disease occuring among animals.

Occurrence Of Disease

- **INCIDENCE**

measures the number of new cases over a certain time period, as compared with the general healthy population.

$$IR = \frac{\text{number of new cases}}{\text{total person-time of observation in population at risk}}$$



- **PREVALENCE**

total number of existing cases with respect to the entire population usually represented by a percentage of the population.

$$P = \frac{\text{number of existing cases in a population}}{\text{total number of people in that population}}$$

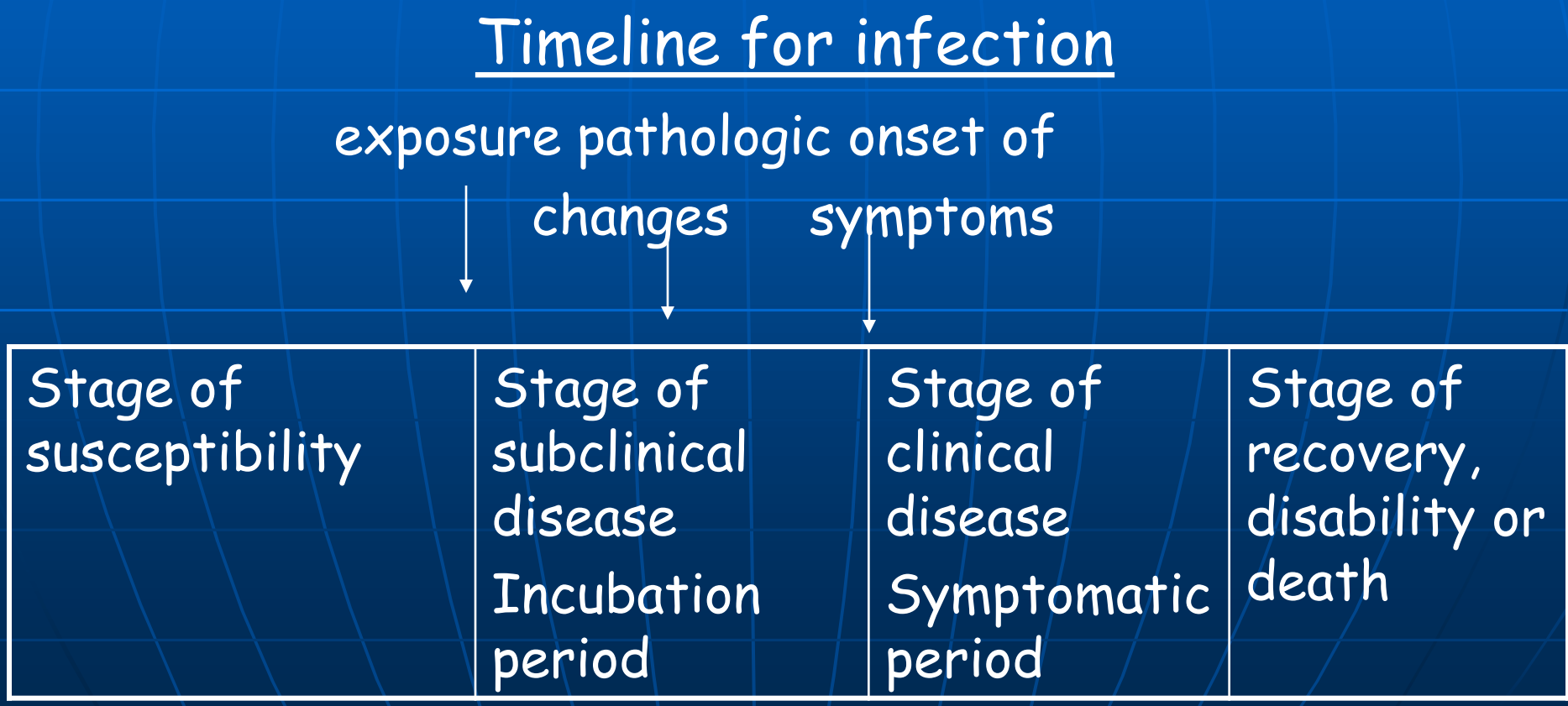
- **Period prevalence (PP):**

probability of occurrence of a condition during a specified period.

$$PP = \frac{\text{number of people with a disease during a period of time}}{\text{total number of people in that population}}$$

Natural history of disease

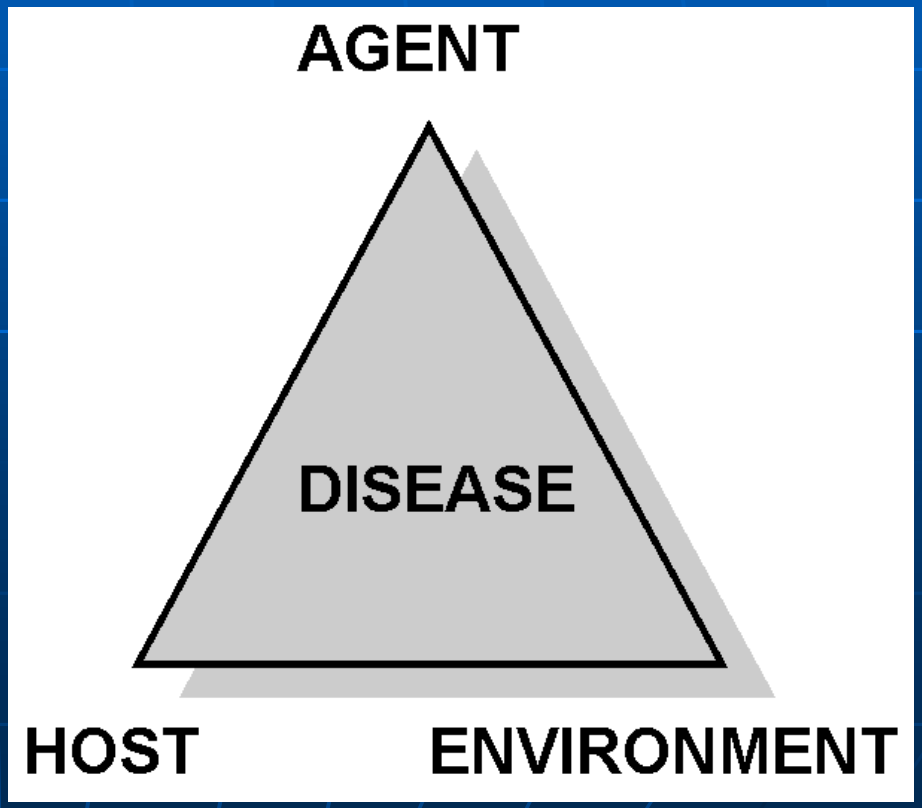
- It refers to the progress of a disease process in an individual over time in the absence of intervention.



Epidemiologic Triad

Disease is the result of forces within a dynamic system consisting of:

- agent of infection
- host
- environment



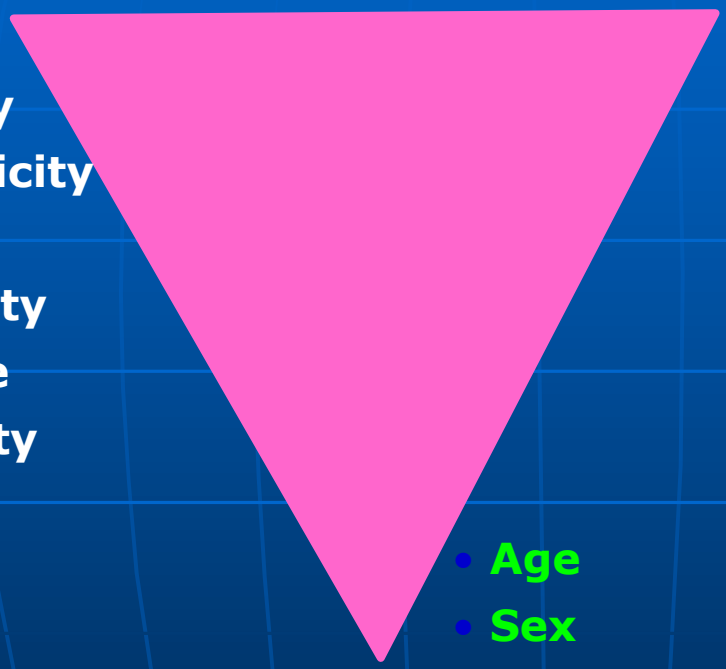
Spectrum of disease

It is that an exposure can lead to varying signs, symptoms and severity of the same disease in the population

Why do we have varying degrees of severity?

The outcome will depend on the interactions of host, agent and environmental factors.

Factors Influencing Disease Transmission



Agent

- Infectivity
- Pathogenicity
- Virulence
- toxigenicity
- Resistance
- Antigenicity

Environment

- Weather
- Housing
- Geography
- Occupational setting
- Air quality
- Food

Host

- Age
- Sex
- Genotype
- Behaviour
- Nutritional status
- Health status
- Immune response

Terms used to describe an infectious disease

- **Agent**: must be present for an infection to occur: Microbial agents
- **Infectivity**: Capacity of the A to enter X in a susceptible host and produce infection or disease. refers to the proportion of exposed persons who become infected.
- **Pathogeneticity:** Capacity of the A to cause disease in an infected host . Refers to the proportion of infected persons who develop clinical disease.
- **Virulence**: refers to the severity of the disease.

Refers to the proportion of persons with clinical disease who become severely ill or die.

- **Toxigenicity:** refers to the agent to produce a toxin or poison
- **Resistance:** refers to the ability of the agent to survive adverse environmental conditions
- **Antigenicity:** refers to the ability of the agent to produce antibodies in the host

Spectrum of disease

- Class A: Inapparent infection: low pathogenicity and low virulence examples: Tuberculosis, polio, AIDS
- Class B :Classic cases (mild or moderate infection)

Frequent clinical disease and few deaths (high pathogenicity and low virulence)

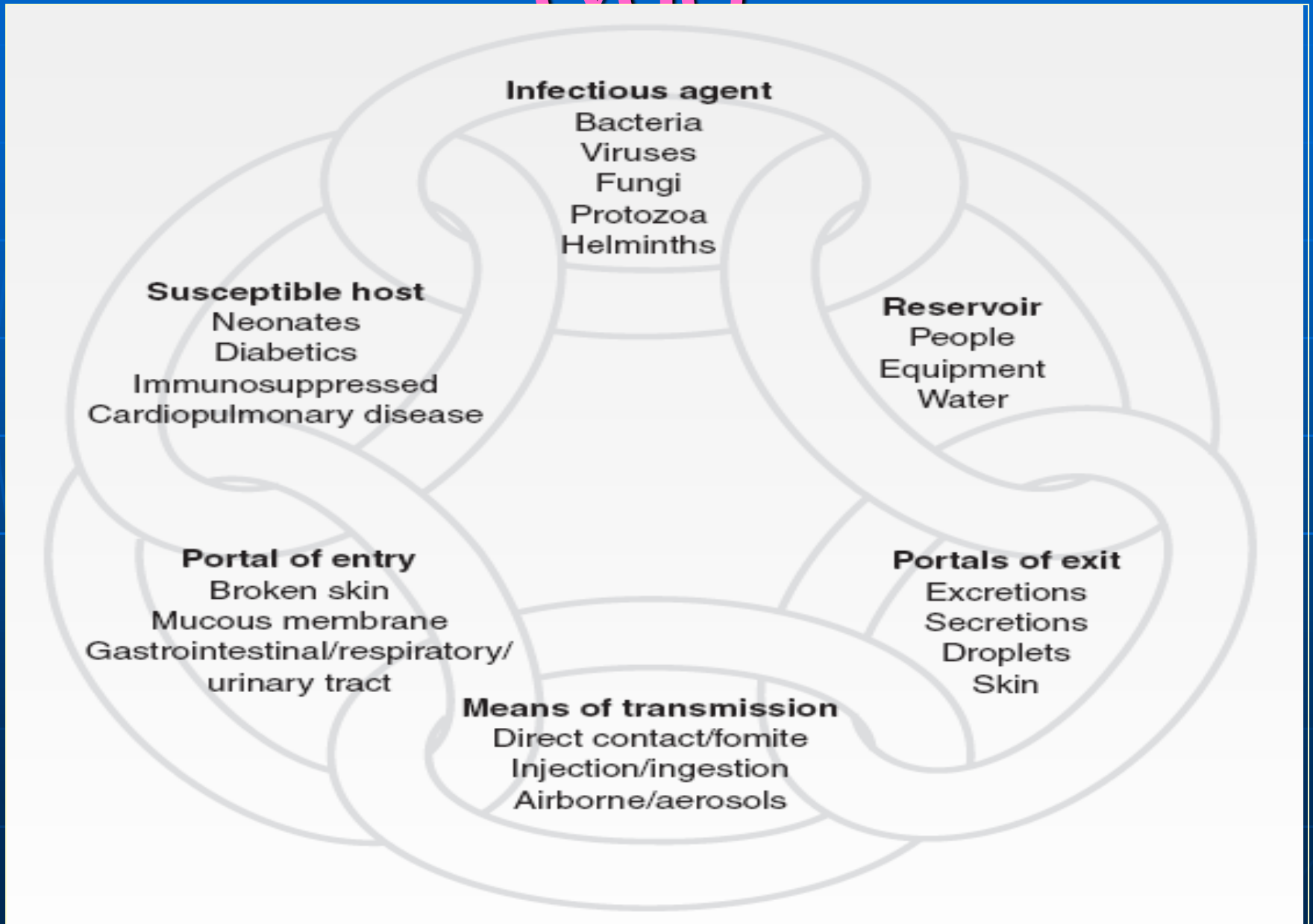
Examples: Measles, Chickenpox

Class C: Severe or fatal infections

(High pathogenicity and high virulence)

Examples: Rabies

Chain of Infection (Infectious cycle)



- Discontinuity of the chain at any link means stoppage of infection and elimination of disease which is the principle f disease control

1. Identification and occurence

- Identification of the disease
- Endemicity of the disease and epidemic nature
- Occurrence and geographic distribution

2. Agent

- Microorganisms are responsible for disease production (viruses, bacteria, protozoa, parasites, fungi).
- Agents factors that affect disease transmission:

Infectivity, Pathogenicity, virulence, Antigenicity and Resistance outside the body.

Mechanisms of disease production (pathogenesis):

Invasiveness: Pneumococcosis

Toxicity: Tetanus, botulism

Hypersensitivity: Tuberculosis

Others: (Immune suppression)

- . Infectivity: The ability of an agent to invade and multiply in a susceptible host
- How to measure ease and spread of infection?
- **Attach rate**

the proportional number of cases developing in a population exposed to the infectious agent. For example, if 100 people at a party ate chicken that was contaiminated with Salmonella, and 10 people cam down with symptoms of disease, then the attack rate was 10%.

$$AR = \frac{\text{Number of new cases "no with disease"}}{\text{Number of people at risk "exposed to contagion"}} \quad \text{per unit of time}$$

- **Pathogenicity:**

Is the ability of the organisms to produce specific clinical reaction after infection

It refers to the proportion of infected persons who develop clinical disease.

It can be measured by: Ratio of clinical to subclinical case= $\frac{\text{clinical cases}}{\text{subclinical cases}}$

Virulence: It refers the ability of organisms to produce severe pathological reaction

It is the proportion of persons with clinical disease who become severely ill or die

It can be measured by: Case fatality rate

$$CFR = \frac{\text{number of people who died from a particular condition}}{\text{total number of people with condition}} \quad \text{per unit time}$$

- **Case fatality rate (CFR):** proportion of people with a particular condition who die from it in a specified time period
- **Morbidity rate**

is calculated as the number of cases of an illness in a given time period divided by the population at risk. Contagious diseases have a high morbidity rate because each infected individual may transmit the infection to several others.

- **Mortality rate**

reflects the percentage of the population that dies from the disease.

$$MR = \frac{\text{number of people who died in a population}}{\text{Total number of people in a population}} \text{ per unit of time}$$

- **Survival rate (SR):** likelihood of living for a specified time period after the diagnosis of a particular condition.

RESERVOIRS OF INFECTION

- The reservoir of an agent is the habitat in which an infectious agent normally lives, grows and multiplies. The reservoirs of infection is important because it affects the extent and distribution of a disease.

- Recognizing the reservoir can help protect a population from disease, because measures can then be instituted to prevent the people from coming into contact with the source.
- Reservoirs include: human, animals and the environment

HUMAN RESERVOIRS

- Two types:
- **SYMPTOMATIC (cases)**

Persons show signs and symptoms of the disease.

- **ASMYPTOMATIC CARRIER**

They are infected persons, apparantly healthy do not show signs or symptoms of the disease, having the organisms in their bodies

Carriers are dangerous because: they donot show any clinical manifestation so they carry normal life., they are not diagnosed and they are not known by others, it is difficult to discover them.

Classification of carrier according to relation to the case

- **1- Incubatory carrier**: the cases become infective before the onset of disease during the incubation period.
- **2- Convalescent carriers:**

The recovered cases continue to excrete the infective agents during the period of convalescence

3- Contact carriers:

Contacts of cases having moderate immunity may be infected and get rid of infection within maximally two weeks.

4- Healthy carriers: Those infected persons from polluted environment

N.B. the following diseases have no carriers:

Influenza Whooping cough

Measles Herpes Zoster

ANIMAL RESERVOIRS

- Both wild and domestic animals are living reservoirs of microorganisms that can cause human disease.
- Diseases that occur primarily in wild and domestic animals and can be transmitted to humans are called zoonose.
- Examples include rabies, Rocky Mountain spotted fever.

ENVIRONMENTAL RESERVOIRS

- The two major nonliving reservoirs of infectious disease are soil and water.
- Soil harbors such pathogens as fungi, and Clostridium botulinum.
- Water that has been contaminated by the feces of humans and other animals is a reservoir for microorganism which are responsible for gastrointestinal diseases.

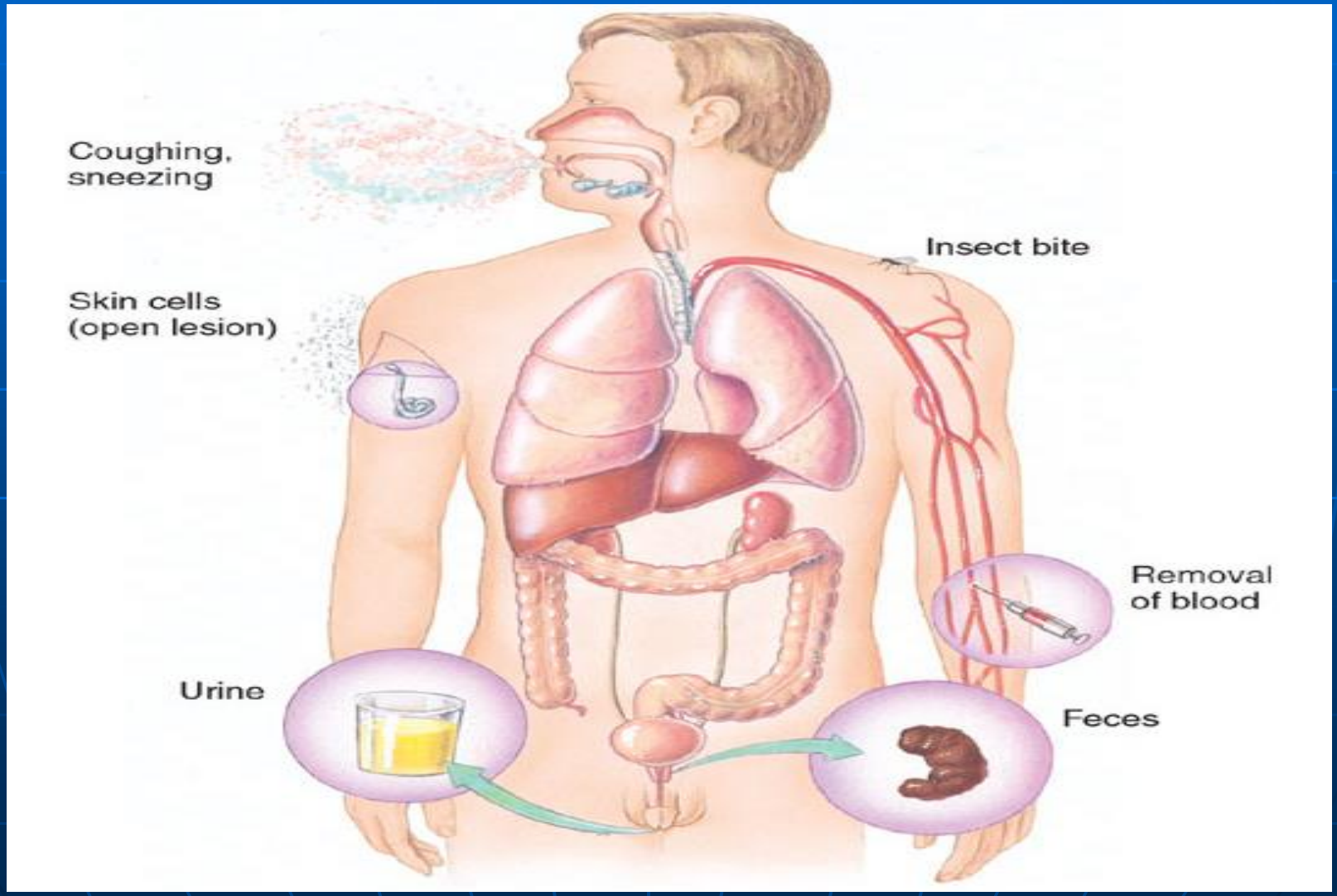
PORTALS OF EXIT

- Microorganism must leave one host in order to be transmitted to another.

Portal of exit is the path by which an agent leaves the source host , through

- Respiratory orifices such as sneezing, coughingsuch as influenza, streptococci
- Gastro intestinal tract: the organism may present withg vomitus e.g. cholera or faecal discharge e.g. typhoid
- Skin
- Urogenital tract urine and genital discharges as gonorrhea
- Blood through contaminated syringes and during blood transfusion e.g. HIV, VIRAL hepatitis

PORTALS OF EXIT



TRANSMISSION OF DISEASE

The causative agents of disease can be transmitted from the reservoir to a susceptible host by 4 routes.

1. **Contact—Direct**
2. **A common vehicle—Indirect**
3. **Airborne route**
4. **Vectors**

Contact transmission

Direct contact

Rabies, rat bite fever, syphilis, gonorrhea, herpes, staphylococcal infections, cutaneous anthrax, genital warts

Indirect contact by fomites

Tetanus, common cold, enterovirus infections, ringworm

Droplets

Common cold, influenza, measles, Q fever, pneumonia, whooping cough

Vehicle transmission

Waterborne

Cholera, shigelliosis, leptospirosis, *Campylobacter* infections

Airborne, including dust particles

Chicken pox, tuberculosis, coccidioidomycosis, histoplasmosis, influenza, measles

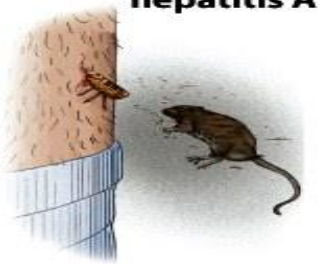
Foodborne

Intoxication with aflatoxins and botulinum toxin, paralytic shellfish poisoning, staphylococcal food poisoning, typhoid fever, salmoelliosis. listeriosis, toxoplasmosis, tapeworms, hepatitis A

Vector transmission

Mechanical (on insect bodies)

***E. coli* diarrhea, salmonellosis, trachoma**



Biological

Plague, malaria, yellow fever, typhus fever, Rocky Mountain spotted fever, Chagas' disease, Lyme disease

The mode of transmission are classified as direct or indirect

- **Direct transmission:**

Due to the agent being within a reasonably close distance of the host as occurs in:

1- droplet infection

2- contact of host skin or mucous membrans with the infectious agent contained in a living tissue e.g. sexually transmitted diseases or contained in inanimate environment e.g. hookworm

3- vertical transmission from mother to child e.g. HIV

Indirect transmisssion

- An agent is carried from a reservoir to a susceptible host by an intermediate
- Ther are four methods:

1- Air borne transmission

2- Vehicle-born

3- fingers

4- Vector-born

1- Air borne transmission:

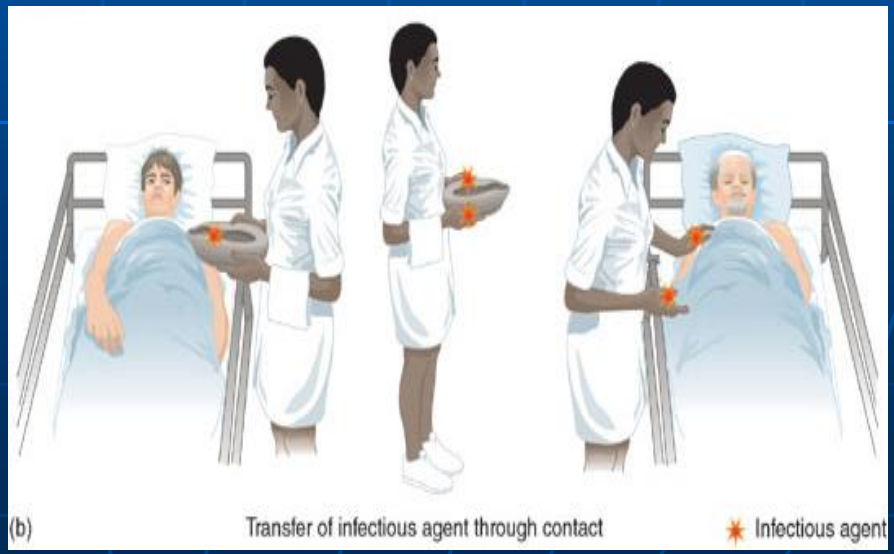
Occurs by particles that are suspended in air(fungal spores) or droplets that have been coughed or sneezed into air(tuberculosis) at a distance of more than 1 meter from the reservoir to host.

2- **Vehicle**

inanimate material carry an infectious agent from reservoir to a susceptible host, they are include: food, water, biological products e.g. blood, vaccines, fomites

(inanimate objects of general use such as toys, toothbrush, bedding or surgical instruments)

- **Common vehicle transmission refers to the transmission of disease agents by a common inanimate reservoir (food, drugs, blood) to an individual.**



VECTORS

- A vector, living invertebrate that carry pathogens from one host to another.
- Vectors are arthropods or molluscs like snails
- Transmission could be either:

-Biological: Bite or feces

-Mechanical:Transported on feet (the agent doesnot multiply or undergo physiologic changes in the vector)

PORTALS OF ENTRY

To cause disease, not only must a pathogen be transmitted from its reservoir to a new host, it must also colonize a surface of or enter the new host.

PORTALS OF ENTRY

- Mucous membranes
- Skin
- Gastrointestinal tract
- Respiratory tract (droplet infection)
- Urogenital tract

MUCUS MEMBRANES

Mucus membranes are present in respiratory, gastrointestinal, genitourinary tracts, and the conjunctiva of the eye. The respiratory tract is the easiest and most frequently traveled portal of entry for infectious microbes. Examples include: cold, pneumonia, influenza, measles, and smallpox.

MUCUS MEMBRANES

Microorganisms can gain access to the gastrointestinal tract in food and water. Most microbes that enter the body are destroyed by HCl and enzymes. Those that survive can cause disease. Examples include: hepatitis A, poliomyelitis, typhoid fever, and cholera.

MUCUS MEMBRANES

An important pathogen capable of penetrating the mucous membranes of genitourinary tract is Trponema pallidum, the causative agent of syphilis.

SKIN

Some microbes gain access to the body through the openings in the skin, the hair follicles and sweat gland ducts. Examples include some fungi and hookworms.

PARENTERAL ROUTES

Parenteral routes are the result of penetration or injury to the surface epithelial tissue and connective tissue. Punctures, injections, bites, cuts, surgery call all establish parenteral routes.

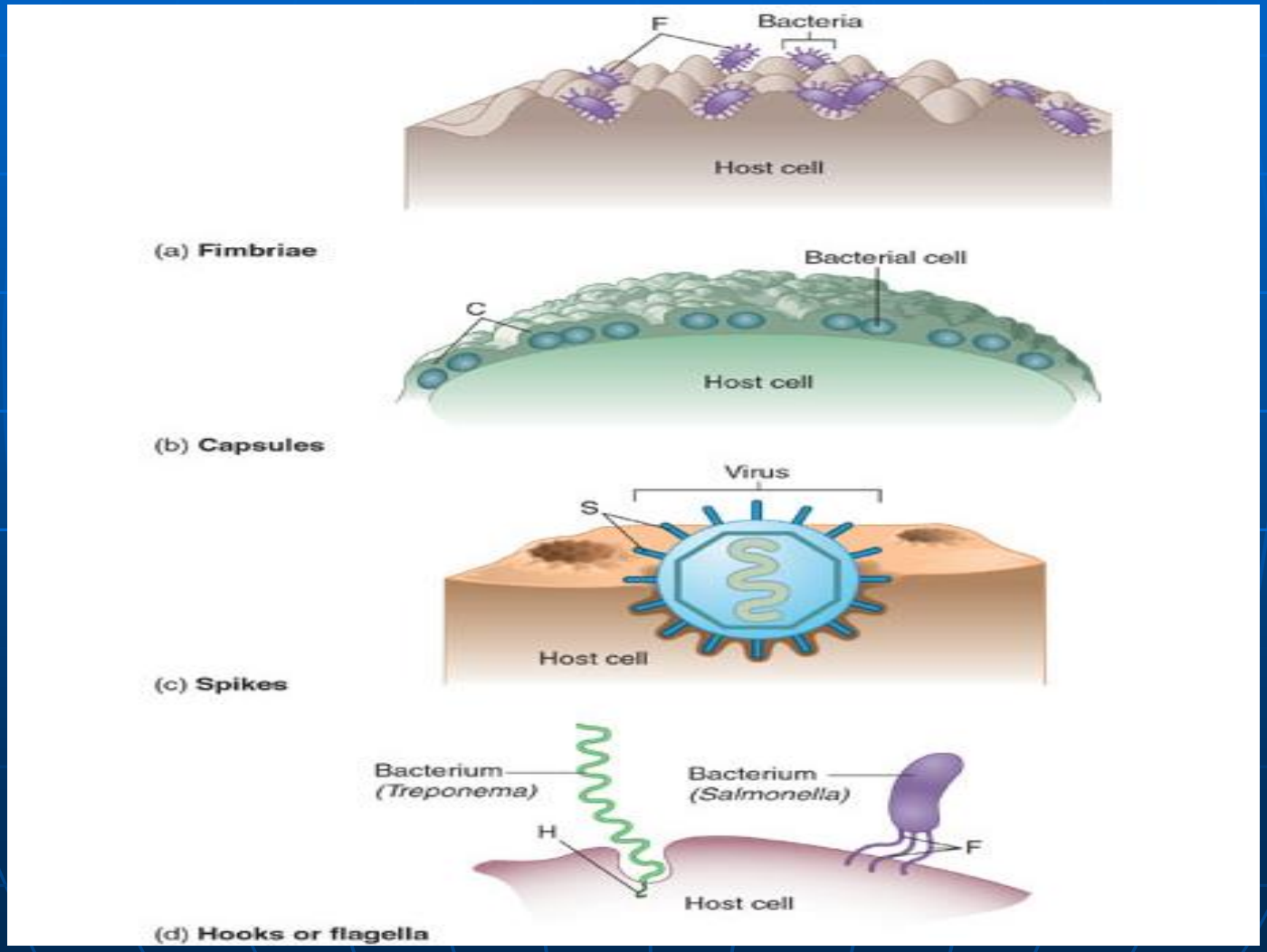
INFECTIOUS DOSE (ID)

- Minimum number of microbes required for infection to proceed
- Microbes with small ids have greater virulence
  - 1 rickettsial cell in Q fever
  - 10 bacteria in TB, giardiasis
  - 10^9 bacteria in cholera
- Lack of ID will not result in infection
- ID_{50} dose that infects 50% of those exposed

PATHOGEN PENETRATION

Once pathogens gain entry to a host, almost all of them have some means of attaching themselves to host tissue. The attachment between pathogen and host takes place by means of surface molecules on the pathogen called adhesins or ligands that bind specifically to complementary surface receptors on the cells of certain host tissues. Once attached, the pathogen is ready to invade a sterile body compartment.

MECHANISMS OF ADHESION



Incubation period

- It is the period from the entry of infectious agent into the human body to the point when the earliest clinical manifestations of the disease are apparent.
- The length of incubation period depends on:

The portal of entry

The rate of growth of the organism in the host

The dosage of the infectious agent

The host resistance

Extrinsic incubation period

- This is the period taken by the infectious agent outside the human body until it becomes infective again to a new individual
- Generation time: it is the duration between the entry of infectious agent into body to the peak infectivity of the host

Host Susceptibility

- **General factors that affect susceptibility and resistance to diseases**

Host factors

Place

Time

Environment

General factors that may increase susceptibility are:

malnutrition

Alcholism

Disease or therapy which impairs the immune response

Communicable disease are classified depending on the portal of entry

- Droplet infection
- Food borne infection
- Contact infection
- Arthropod born infection

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